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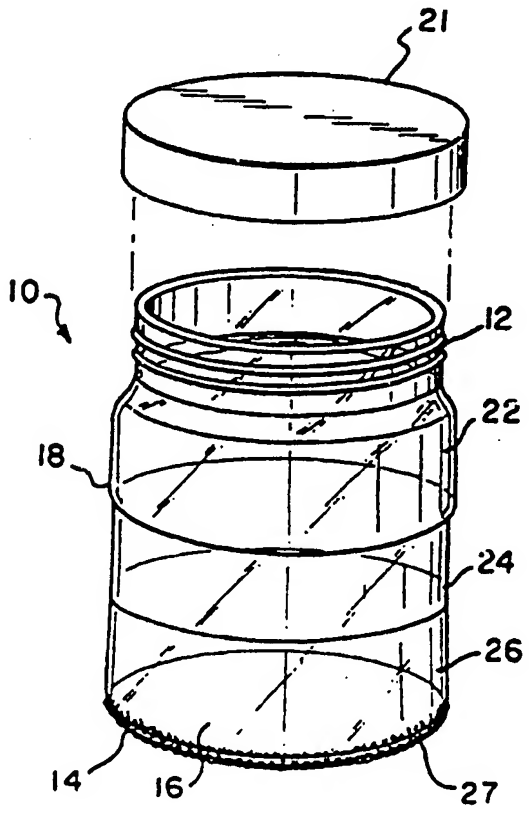
(54) Title: COLLAPSIBLE, MICROWAVABLE CONTAINER

(57) Abstract

The present invention provides a collapsible, microwavable container for storing and heating foods. The container is substantially clear in appearance and includes an upper open end (12), a lower end (14) closed by a bottom wall (16), and a peripheral side wall (18) extending between the upper and lower ends which is movable between extended and collapsed positions upon the exertion of a force. The peripheral side wall (18) of the container includes upper (22), lower (26) and intermediate (24) portions. In a preferred embodiment, the container walls are comprised of outer and inner layers of a thermoplastic polymer such as polypropylene having a flex modulus of about 150,000 psi (1034 MPa) and an intermediate layer having a lower flex modulus than the outer and inner layers. In an alternative embodiment, the container may comprise a single layer where the upper and lower portions of the peripheral side wall are formed from a thermoplastic polymer having a first flex modulus and the intermediate portion is formed from a polymer having a lower flex modulus.



COLLAPSIBLE, MICROWAVABLE CONTAINER

The present invention relates t a collapsible, microwavable container for storing and heating foods comprising multiple layers or a single layer of thermoplastic polymers which permit the container to move between collapsed and extended positions

Many reusable thermoplastic containers of various sizes and shapes are known in the art which are used for packaging and storing a variety of foods Such containers are useful when storing foods which are to be used up over a period of time because the food is easily resealed in the container with the use of a removable lid or cover. Reusable, collapsible containers are also known which are capable of being collapsed as the food is used ove time to save storage space

Such collapsible containers are desirable as they are reusable, and they may be compactly stored in a collapsed position, thus maximizing storage space However, while such collapsible containers provide a convenient storage method, the containers are unsuitable for heating foods in a microwave oven as the containers are constructed of only a single layer of a polymer which is not sufficiently heat resistant to maintain the structural integrity of the containers under microwave cooking conditions. In general, containers made from thermoplastic polymers or copolymers with a softening temperature below 100°C are not sufficiently resistant to hot foods when heated in a microwave oven, and are subject to deformation and leaking.

U.S. Patent No 5,219,628 discloses a multi-layer container suitable for use in microwave cooking comprising a substrate layer of a thermoplastic polymer and an inner protective layer comprising a blend of polymers which contacts the food However, the polymers comprising the container structure are relatively rigid and are not suitable for use in a collapsible container.

Further, when heated, such as in a microwave oven, many thermoplastic containers are subject to staining by foods, which is undesirable for a reusable container Another disadvantage of such containers is that they have low optical clarity, making it difficult for a consumer to see the food or liquid stored inside

Accordingly, the need still exists in this art for a thermoplastic container which is flexible enough to be collapsed for compact food storage, rigid enough to withstand microwave heating, and which maintains optical clarity.

The present invention meets that need by providing a reusable, thermoplastic container which is microwavable for cooking and reheating food, which is collapsible to provide compact storage, and which maintains excellent optical clarity The container may be produced by coextrusion or coinjection followed by blow molding or by sequential molding techniques

In a preferred embodiment of the invention, the walls of the container are formed from alternating layers of polymers having different properties which provide flexibility for permitting collapse of the container while maintaining rigidity and stain resistance for microwave heating. In one embodiment, the container walls comprise outer and inner layers of a thermoplastic polymer having a first flex modulus and an intermediate (second) layer of a thermoplastic polymer having a lower flex modulus than the outer and inner polymer layers. Preferably, the outer and inner layers have a flex modulus of about 150,000 pounds per square inch (psi) (1034 MPa).

In a preferred embodiment of the invention, the outer and inner thermoplastic polymer layers comprise polypropylene. Of the total wall thickness, the outer layer of polypropylene preferably comprises 18-22% of the total thickness, the intermediate thermoplastic polymer layer comprises 55-60% of the total thickness, and the inner layer of polypropylene comprises 19-27% of the total thickness.

The intermediate layer preferably comprises a compatible polymeric "glue" layer such as, for example, a copolymer of ethylene and vinyl acetate or polyethylene. In a variation of this embodiment, the container walls may include "glue" layers which join the intermediate layer to the outer and inner layers. The "glue" layers preferably comprise copolymers of ethylene and vinyl acetate, ethylene and acrylic acid, or polyethylene.

In another embodiment of the invention, the container walls comprise a blend of polypropylene and polyethylene, where the blend comprises at least 50% by weight polypropylene.

In still another embodiment of the invention, the container walls comprise only a single layer formed from polymers having different flex moduli. In this embodiment, the upper and lower portions of the peripheral side wall of the container are formed from polypropylene having a first flex modulus, and the intermediate portion is formed from a thermoplastic polymer having a lower flex modulus than polypropylene. Preferably, the outer layers of polypropylene have a flex modulus of about 150,000 psi (1033 MPa) while the intermediate portion is formed from a softer polypropylene having a low flex modulus which is approximately 15,000-80,000 psi (103-552 MPa).

The container is substantially clear in appearance and has a haze value of no more than 40%. The haze value refers to the degree of cloudiness in the thermoplastic layers comprising the container walls. By substantially clear, it is meant that the container walls are sufficiently transparent such that one can see the contents of the container.

While the container is capable of holding most container sized products commonly found in households, it is particularly adaptable to holding foods, either solids or liquids, and is resistant to leakage and deformation which may occur as a result of microwave heating. The container is also resistant to staining by foods. The container may be repeatedly extended and collapsed during use, and may be repeatedly refrigerated and reheated

Acc rdingly, it is a feature of the present invention to provide a collapsibl , microwavable container which is reusable and is suitable for heating and storing food It is .. further feature of the invention to provide a container which is substantially clear and resistant to staining. These, and other features and advantage of the present invention, will become apparent form the 'ollowing detailed description, the accompanying drawings, and the appended claims

Fig. 1 is a perspective view of the collapsible container of the present invention,

Fig. 2 is a side view of the container shown in Fig. 1;

Fig. 3 is a cross-sectional view of the container wall showing outer, inner and intermediate layers taken along line 3--3 in Fig. 2;

Fig. 3a is a cross-sectional view of an alternative embodiment of the container wall comprising outer and inner layers;

fig. 3b is a variation of the embodiment shown in fig. 3 including outer, inner, intermediate, and glue layers;

Fig. 4 is a side view of the container in a collapsed position;

Fig. 5 is an enlarged cross-sectional view of the container taken along line 5--5 in Fig. 4; and

Fig. 6 is a bottom view of the container taken along line 6--6 in Fig. 5.

The container of the present invention provides a combination of properties which has not been achieved with the use of prior art thermoplastic containers which utilize only a single layer of polymer or blends of polymers. The container structure of the present invention uses either multiple layers or polymers having different properties or a single layer, but with different sections of the container comprising different polymers with differing properties. Where the container utilizes a multi-layer structure, outer and inner layers of a polymer having a high flex modulus of greater than 80,000 psi (552 MPa), preferably 100,000 psi (689 MPa) to 200,000 psi (1379 MPa), and most preferably of about 150,000 psi (1033 MPa) (as measured by ASTM method D790 B) are used to provide sufficient stiffness and resistance deflection under load when heated or otherwise. The intermediate layer positioned between the outer and inner layers comprises a softer polymer of a lower flex modulus (that is, between 15,000-80,000 psi) (103-552 MPa) which provides flexibility to the container wall during collapsing. Thus, by utilizing polymers with different properties in a multi-layer construction, the container of the present invention provides both the flexibility needed for collapsing and the rigidity required for microwavability.

Alternatively, the container structure may comprise a single layer made up of upper, lower and intermediate portions, where the upper and lower portions are formed from a polymer having a high flex modulus preferably of about 150,000 psi (1033 MPa), and the intermediate porti n being formed from a polymer having a lower flex modulus Thus, the

contain of the present invention may utilize only a single layer which also pr vides the desired pr perties f collapsibility and microwavability

With reference t Figs. 1 and 2, a collapsible, microwavable multi-layer contain r 10 is illustrated. The container 10 includes an upper open end 12, a lower end 14 closed by a bottom wall 16, and a peripheral side wall 18 extending between the upper and lower ends The peripheral sidewall is shown in the extended position in Fig. 1, and includes an upper portion 22, an intermediate portion 24, and a lower portion 26 The upper portion of the peripheral sidewall has a thickness of between 40-60 mils (1.02-1.52 mm). The lower portion f the peripheral sidewall has a thickness of between 20-60 mils (0.51-1.52 mm), and the intermediate portion of the sidewall is much thinner, having a thickness of from 3-12 mils (0 08-0.30 mm) which permits collapse of the container by the folding of the intermediate layer While illustrated in a preferred form with upper, intermediate, and lower sidewall portions, it will be apparent to those skilled in the art that the container may be made with as few as one sidewall portion of a high flex modulus polymer and one sidewall portion having a lower flex modulus or as many as several portions, each of high and lower flex modulus polymers.

As shown in Fig. 2, the upper and lower sidewall portions 22 and 26 are slightly tapered so as to facilitate collapsing and extension of the container. The container 10 may be collapsed to the position shown in Figs. 4 and 5 by exerting a closing force of from about 2 to 10 pounds (8.90-44.48 N) at the upper portion of the container. This causes the intermediate portion of the sidewall to fold back on itself such that the lower portion of the sidewall 26 is telescoped within the upper portion 22 as shown in the cross-sectional view of the container in Fig. 5. As can be seen in Fig. 4, the container can be approximately one-half of its original height in the collapsed position. To revert the container to its fully extended position, a user may grip the container at opposite ends and pull the container in opposite directions, which requires an opening force of from about 5 pounds (22 29 N)). As illustrated, a roughened surface 27 is provided around the periphery of the lower portion of the container to provide a gripping surface.

Fig. 3 illustrates a cross section of one embodiment of the container wall in which the wall comprises outer and inner polymer layers 28 and an intermediate polymer layer 30. Preferably, the outer and inner layers comprise polypropylene. The intermediate layer 32 has a lower flex modulus than the polypropylene layers and may comprise a copolymer of ethylen and vinyl acetate or polyethylene or a low flex modulus polyproylene (hereinafter described) Of the total container wall thickness, the outer layer comprises 18-22% of the total thickness, the inner layer comprises 19-27% of the total thickness, and the intermediate layer comprises 55-60% of the total thickness. While the actual thicknesses f the upper, lower, and intermediate portions f the container wall will vary, as described previously, the percentages of polymers making up the layers in those wall portions will be in the above-described ranges

Fig 3 illustrates and alternativ embodiment of the invention in which the container wall comprises outer layer 32 and inner layer 34 where the inner layer (that is, the layer in contact with the contents of the container) comprises polypropylene and the outer layer comprises either a low flex modulus polypropylene, a copolymer of ethylene and vinyl acetate, or a copolymer of ethylene and acrylic acid Typically, the inner layer will comprise from 10-50% of the total wall thickness, while the outer layer will comprise from about 90-50% the total wall thickness

Fig 3b illustrates a variation of the embodiment shown in Fig 3 in which the container walls include glue layers 36 which join the intermediate layer 30 to the outer and inner polypropylene layers 28 The glue layers may comprise copolymers of ethylene and vinyl acetate or ethylene and acrylic acid In order to obtain good layer adhesion, the copolymer of ethylene and vinyl acetate preferably should comprise at least 11% vinyl acetate A higher percentage of vinyl acetate may be used where the ethylene vinyl acetate copolymer is blended with another polymer

A preferred high flex modulus polypropylene for use in the present invention is Pro Fax SV 256 (trademark), commercially available from Himont Incorporated Other suitable grades of polypropylene include PD199 and Pro Fax 7624 (trademark). Suitable low flex modulus polypropylenes include KS-050 (flex modulus 18,500 psi (127 MPa), commercially available from Himont. The use of polypropylene has several advantages in that it provides excellent optical clarity, superior high temperature performance, and is available in a wide range of grades. Suitable copolymers of ethylene and vinyl acetate include Elvax 3135SB, commercially available from DuPont A suitable copolymer of ethylene and acrylic acid is commercially available as Plexar (trademark).

When the intermediate layer comprises polyethylene, a suitable resin for use is a substantially linear copolymer resin of ethylene and an α-olefin as taught in commonly-assigned published PCT application PCT/US92/08812, published April 27, 1993, the disclosure of which is hereby incorporated by reference. These copolymer resins are commercially available from The Dow Chemical Company as polymer resins made using Insite™ constrained geometry catalyst technology (CGCT) Constrained geometry catalysts are described or referenced in U S Patents 5,064,802 and 5,132,380 and EPO Publication 0416815 of March 13, 1991, and equivalent South African Patent 90/6969 granted May 27, 1992, and EPO Publication 0520732 of November 18, 1992 The catalysts may be generally characterized as comprising a metal coordination complex of a metal of Groups 3-10 or the Lanthanide series of the Periodic Table of Elements and a delocalized π-bonded moiety substituted with a constrain-inducing moiety

Such substantially linear copolymers have the strength and t ughness of linear low density polyethylene (LLDPE) but with processability similar to highly branched low density polyethylene (LDPE). Thus, the polymers have processing indices (PI's) less than or equal to 70% of those of a comparable linear olefin polymer and a critical shear rate at onset of surface melt

fracture of at lest 50% greater than the critical shear rate at onset of surface melt fracture of a traditional linear olefin polymer at about the same I_2 and M_w/M_n, where I_2 is the melt index measured according to ASTM D-1238, Condition 190°C/2 16kg (formerly known as "Condition E"), M_w is the weight average molecular weight, and M_n is the number average molecular weight of the polymer. The substantially linear copolymers will have from 0 01 to 3 long chain branches/1000 carbon atoms along the polymer backbone, where long chains are defined as a chain length of at least 6 carbon atoms.

If desired, the polymer resin may be combined with a comonomer of propylene to form a copolymer. The substantially linear copolymer resins are also suitable for use as the outer layer where the container comprises only outer and inner layers as shown in Fig 3, and may be used as the intermediate portion where the container is comprised of a single layer

The multi-layer container of the present invention is preferably produced by coextruding the polymer layers followed by a conventional blow-molding process, although other processes such as injection molding may be employed The preferred process for making the container includes the step of extruding the layers as a tubular parison between a pair of separated mold halves which form the desired container shape. The mold halves are then closed and the parison is blown into engagement with the interior surfaces of the mold.

Where the container wall comprises outer and inner layers of polypropylene and an intermediate layer of polyethylene or an ethylene vinyl acetate copolymer, the intermediate layer may be coextruded with the polypropylene layers. Alternatively, the outer, inner and intermediate layers may be bonded together in the hot-melt state using adhesive polymers such as copolymers of ethylene and vinyl acetate or ethylene and acrylic acid which function as glue layers as shown in Fig. 3b.

Where the container structure is comprised of a single layer, a sequential blow molding process is preferably used in which the polymeric materials are extruded into the parison in sequence. For example, to form the container shown in Fig 1, the polypropylene having a high flex modulus would be extruded into the parison first, followed by the softer (that is, lower flex modulus) polypropylene or substantially linear copolymer resin, and finally, the polypropylene having a high flex modulus Thus, the single layer container formed comprises upper and lower portions 22 and 26 formed from polypropylene having a high flex modulus and an intermediate portion 24 formed from polypropylene of a lower flex modulus A suitable method for carrying out this embodiment of the invention is described by Schwaegerle et al, "Sequential Extrusion Blow Molding", Society of Plastic Engineers (October 4-6, 1993) pp. 283-293

Another alternative method of making the single layer container is to inject the polymeric materials around a mandrel such that the top and bottom sections 22 and 26 of the container are injected with polypropylene having a high flex modulus while the center section 24 is injected with a softer polypropylene

The container is preferably formed so as t pr vide a container having a generally cylindrical shape from top to bottom, with a round closed bottom as shown in Fig. 6 and an open upper end as shown in Fig. 1. The open end should be wide enough to allow access to and cleaning of the interior of the container or a wide mouth container.

Also as show in Fig. 1, the container preferably includes a threaded portions 20 for receiving a screw-on closure 21. However, it should be appreciated that other conventional caps or lids may be employed in the present invention. It should also be appreciated that the shape and size of the container may vary. For example, the container may be designed as a 2, 3, 6, 8, or 9 (473, 710, 1420, 1893, 2129 ml) cup container and may have a cylindrical, oval, square or other shape as desired.

Other variations of the container structure are within the scope of the invention For example, the lower sidewall 26 of the container may be textured or roughened as shown at 27 to enable a user to grip the container during collapse and extension of the container.

To aid in the collapsing and opening of the container, the polymers may contain from 0.1 to 3.0%, and more preferably, about 1% of a slip additive and/or antiblocking agent.

In order to maintain a suitable optical clarity, the container should have a haze value of about 40%, preferrably of no more than about 40% (but center section 24 may have a somewhat higher haze level). The haze value may be measured by the Digital Photometric Method (ASTM D-1003) using a Gardner Model TG5500. The optical clarity of the container is maintained even after microwaving food due to the inner polypropylene layer of the container wall which is resistant to staining.

In order that the invention may be more readily understood, reference is made to the following example, which is intended to be illustrative of the invention, but is not intended to be limiting in scope.

Example 1

A collapsible, multi-layer container was produced in accordance with the present invention using Bekum blow molding equipment. The container structure comprised outer and inner layers of polypropylene and an inner layer of ethylene vinyl acetate

The multi-layer container which was formed had a total thickness of about 50 mils (1.27 mm), with the outer and inner layers comprising about 40% of the total film thickness

The container was tested to determine acceptable resistance to microwave cooking processes by placing approximately 20 oz. (0.567 kg) of a commercially prepared can of chili into the container. The container was then heated, uncovered, in a microwave oven under full power (750 watts) for about 10 minutes After each minute of heating, the food was stirred thoroughly and the container was inspected for deformation and staining The container was found to have minimal staining and was resistant to deformation. No leaks were noted.

The haze value of the container was measured after cooking using Gardner Model TG5500 and was found to be 33%.

Example 2

A series of generally cylindrically-shaped containers were formed over a three day period by blow molding a three-layer A/B/A construction of polypropylene (Pro Fax SV 256) in the outer layers and a copolymer of ethylene and vinyl acetate in the inner layer. A polypropylene slip additive was included in an amount of about 1% by weight in the inner and outer layers. The slip additive was found to improve the opening and closing of the containers.

Tests and measurements were performed on representative samples of the containers as reported below in Table 1 on the opening force required, the layer distribution, the layer thicknesses around the top, middle, and bottom of the container, and the haze value.

TABLE I

Opening Force lbs (metric) (Newtons)				Layer Dist. %		HOOP Thickness-mils (millimeters)			HAZE (%)
C n-tainer	1	2	3	Inner PP	Outer PP	TOP	MID	BOT	%
2-16A	9.8 (43.6)	7.6 (33.8)	7.2 (32.0)	23.7%	19.5%				39-49
2-16B	9.0 (40.0)	6.6 (29.4)	6.2 (27.6)	21.8%	18.6%	44-56 (1.12-1.42)	3.7-8.0 (0.09-0.20)	32-60 (0.81-1.52)	
2-17A	7.9 (35.1)	7.0 (31.1)	6.8 (30.2)	25.0%	19.5%	47-58 (1.19-1.47)	3.9-8.9 (0.10-0.23)	28-61 (0.71-1.55)	32-35
2-17B	9.7 (43.1)	7.4 (32.9)	6.9 (30.7)	26.7%	20.2%				
2-18EA	10.3 (45.8)	7.8 (34.7)	6.2 (27.6)	24.9%	22.0%	45-57 (1.14-1.45)	4.0-7.7 (0.10-0.20)	26-60 (0.66-1.52)	30-34
2-18EB	10.3 (45.8)	7.8 (34.7)	7.2 (32.0)						
2-18LA	10.0 (44.5)	7.4 (32.9)	7.1 (31.6)	19.4%	20.0%				30-34
2-18LB	9.4 (41.8)	7.3 (32.5)	6.9 (30.7)			48-58 (1.22-1.47)	3.7-7.4 (0.09-0.19)	23-59 (0.58-1.50)	

While certain representative embodiments and details have been shown for purposes of illustrating the invention, it will be apparent to those skilled in the art that various changes in the methods and apparatus disclosed herein may be made without departing from the scope of the invention, which is defined in the appended claims.

WHAT IS CLAIMED IS:

1. A collapsible, microwavable multi-layer container which includes an upper open end, a lower end closed by a bottom wall, and a peripheral side wall extending between said upper and lower ends which is movable between extended and collapsed positions upon the exertion of a force, said container walls comprising an inner layer of a thermoplastic polymer having a first flex modulus and a second layer of a thermoplastic polymer having a lower flex modulus than said inner polymer layer.

2. The container of claim 1 further including an outer layer of said thermoplastic polymer having said first flex modulus

3. The container of claim 1 wherein said peripheral side wall in its extended position includes an upper portion, an intermediate portion, and a lower portion, wherein said intermediate portion has a wall thickness which is less than the wall thicknesses of said upper and lower portions.

4. The container of claim 2 wherein the wall thicknesses of said upper and lower portions are substantially equal.

5. The container of claim 2 wherein when said container is in said collapsed position, the upper and lower portions of said peripheral sidewall are telescoped within one another and said intermediate portion is folded therebetween.

6. The container of claim 1 wherein said inner polymer layer has a flex modulus of about 150,000 psi (1034 MPa).

7. The container of claim 1 wherein said second layer.

8. The container of claim 2 wherein said outer layer comprises polypropylene and comprises from 18-22% of the total container wall thickness, said second layer of thermoplastic polymer comprises a substantially linear copolymer resin of ethylene and an α-olefin and comprises from 55-60% of the total thickness, and said inner layer comprises polypropylene and comprises from 19-27% of the total thickness

9. The container of claim 1 wherein said container walls further include glue layers which join said second layer to said outer and inner layers

10. The container of claim 2 wherein said outer and inner layers comprise polypropylene, said second layer comprises polyethylene, and glue layers comprising copolymers of ethylene and vinyl acetate or ethylene and acrylic acid adhere the inner, second, and outer layers together.

FIG-3

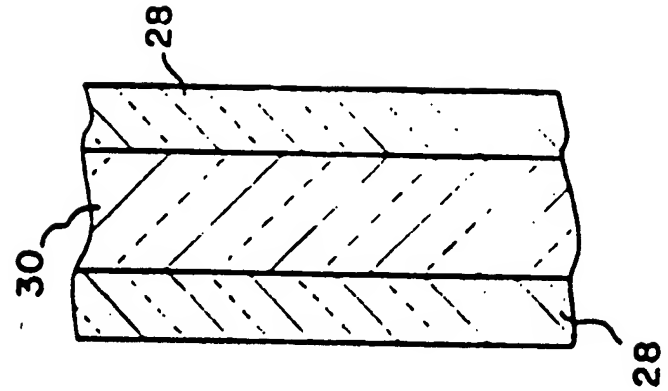


FIG-2

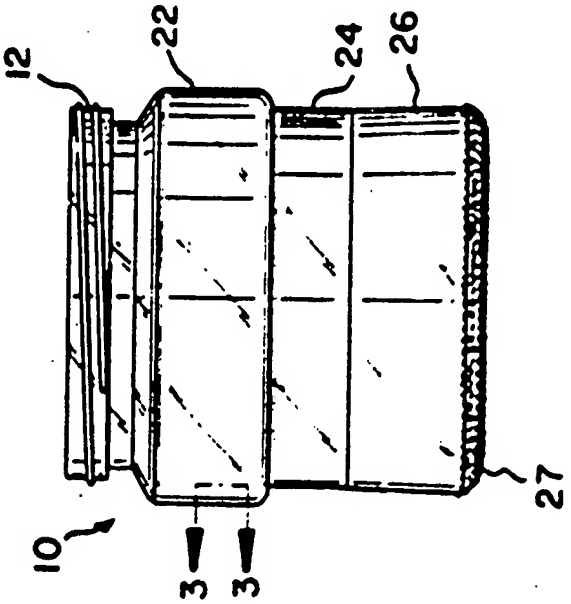


FIG-1

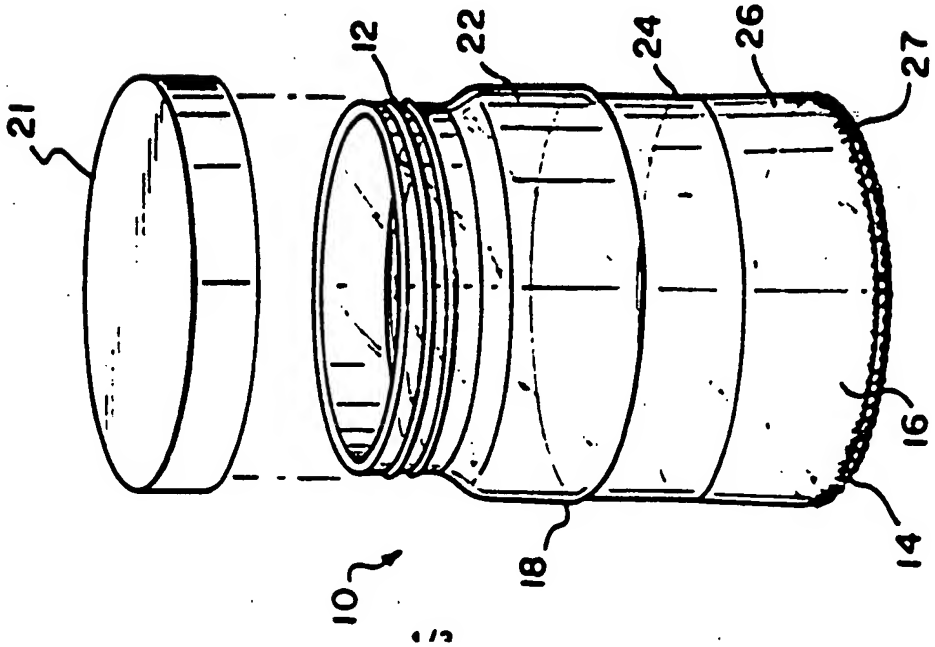


FIG-4

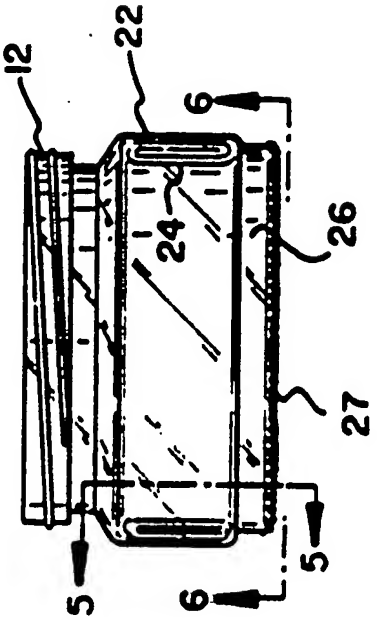


FIG-6

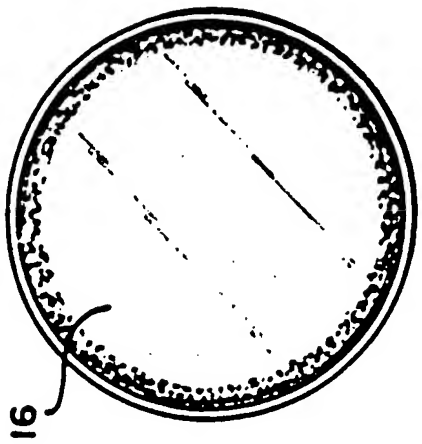


FIG-3A

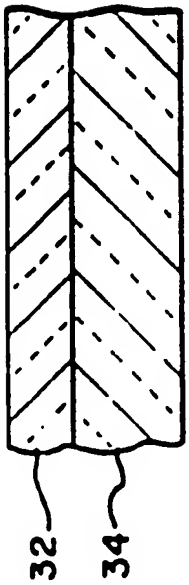


FIG-3B

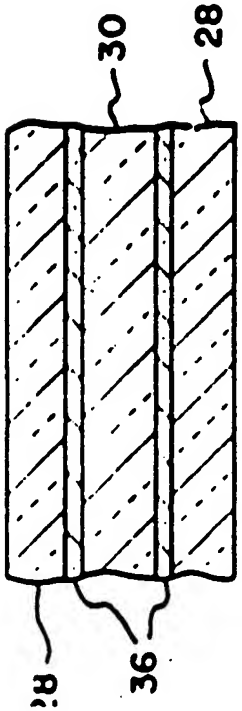
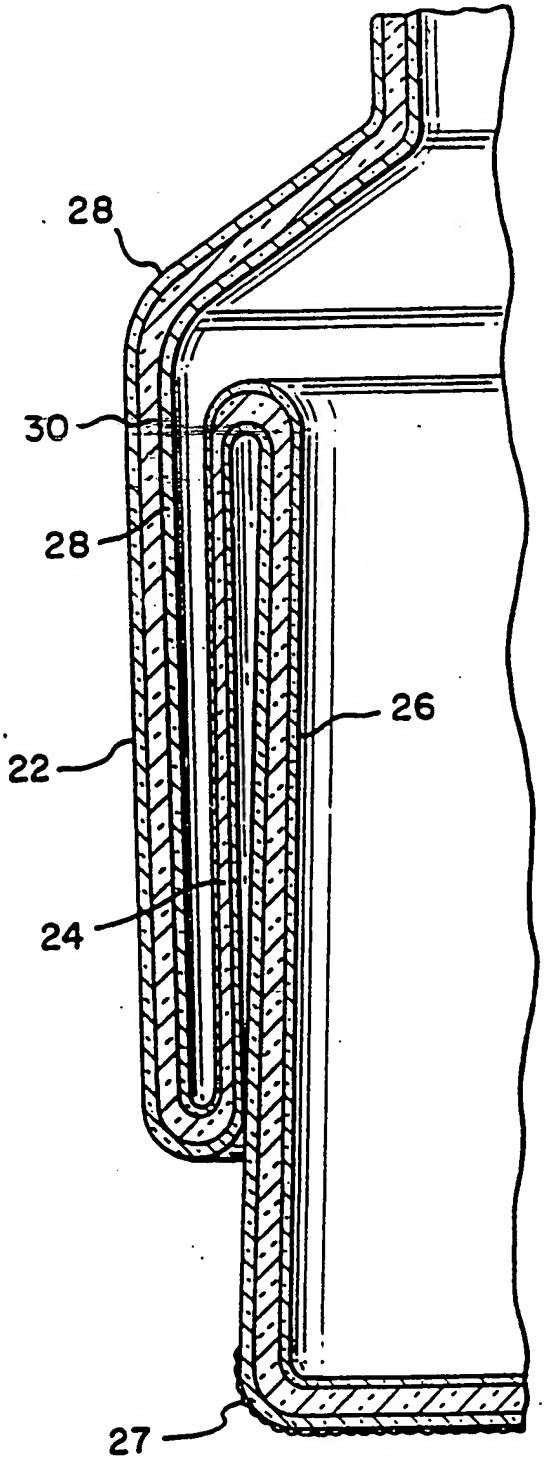


FIG-5



INTERNATIONAL SEARCH REPORT

International Application No.
PCT/US 95/01344

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B65D81/34 B65D1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 356 576 (MBM MASCHINENBAU) 7 March 1990 see column 5, line 23 - column 6, line 11; figures 1-7	1,2,4,7
Y	see column 7, line 1 - line 25	3,5,6,9, 10
Y,P	WO,A,94 24002 (E. ROBBINS) 27 October 1994 see abstract; figures 1-4	3,5
Y,P	EP,A,0 595 701 (BOLLORE TECHNOLOGIES) 4 May 1994 see abstract; examples 10,11	6,9,10
A	EP,A,0 538 747 (HOECHST) 28 April 1993 see abstract; claim 1	8

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
31 May 1995	27.06.95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,	Ramirez F

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/01344

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US,A,3 939 888 (T. SCARNATO) 24 February 1976 see the whole document	1-5

INTERNATIONAL SEARCH REPORT

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